July 1979 ESO 680

Effects of Rail Abandonment Upon Grain Marketing and Transportation Costs in Central and Southwestern Ohio

By
Donald W. Larson
Michael Kane

Ohio Agricultural Research and Development Center
U.S. 250 and Ohio 83 South
Wooster, Ohio

Effects of Rail Abandonment Upon Grain Marketing and Transportation Costs in Central and Southwestern Ohio

Introduction

Transporting agricultural products and farm inputs frequently presents problems to U. S. agriculture. Not unlike many earlier periods, a number of grain transportation problems once again became severe in the early 1970s. They include shortages of transportation equipment, bankruptcies of some railroads and near financial collapse of others, energy shortages, rail line abandonment and higher transport costs. Furthermore, the uncertainty of future rail service due to congressionally mandated rail reorganization added to the complexity of the problem in the Northeast and Midwest of the U.S. An important element of rail reorganization--the abandonment of economically non-viable rail lines--is the subject of this paper. More specifically, the purpose of this paper is to evaluate the impact of rail line abandonment on grain marketing and transportation costs in central and southwestern Ohio.[1/] This evaluation will include the impact on: a) total costs of transportation, storage and handling of grain, b) grain shipping patterns and transport modes, c) location of individual elevator operations and d) farm storage activities. The Ohio Grain Rail Abandonment Model (OGRAM) is used to evaluate this grain (corn, soybeans and wheat) transportation problem.

The Problem

To provide the legal and financial means for rail reorganization, Congress passed the Regional Rail Reorganization Act of 1973 (RRRA) and the Rail Revitalization and Regulatory Reform Act of 1976 (RRRRRA) [15]. The U. S. Railway Association, created by the RRRA of 1973, is charged with the responsibility to develop a plan for restructing the railroads in the Northeast and Midwest. Ohio, a surplus grain producing state, is one of 17 states in the Northeast and Midwest in the process of rail reorganization under the RRRA of 1973 while many states outside this region are also in the process of rail reorganization under the RRRRA of 1976. The Final System Plan of the U. S. Railway Association (U.S.R.A.) defines the new structure and the legal and financial conditions of the reorganization in the Northeast and Midwest [19].2/ A part of this Plan also established criteria by which rail line segments would be judged as financially viable or "potentially excess."3/ Using these criteria, approximately 6,000 miles of low traffic lines in the Northeast and Midwest were designated as "potentially excess." Low traffic lines designated as "potentially excess" would be abandoned unless they are subsidized by shippers or local and/or state governments with financial assistance provided by the Federal Government on a matching basis.4/ To qualify for the rail service continuation subsidies, each state must develop a state rail plan and designate a state agency (e.g. the Ohio Rail Transit Authority) to implement the plan.

The next section of this paper describes the Ohio rail transportation system as well as the importance of the various transport modes in grain shipments. The third section presents the structure of the OGRAM model used to analyze the effects of rail line abandonment on grain marketing and transportation costs, and in addition this section also describes the data required for the study. The fourth section compares the results of a basic optimal solution prior to rail line abandonment with the results of a rail abandonment solution. Some conclusions about the effects of rail line abandonment upon grain marketing and transportation costs are presented in the last section.

Grain Transportation in Ohio

As recently as 1975, Ohio had approximately 7,500 miles of railroad track with about 3,900 owned by private solvent carriers and about 2,400 operated by Conrail. Of the remaining 1,200 miles, primarily low traffic lines, the U.S.R.A. Final System Plan designated a total of 885.5 available for subsidy but only 225.5 miles of these rail lines were recommended for subsidy in the Ohio Branch Line Plan and only 160 miles of these rail lines remain in service [13]. Further reduction of the Ohio rail system (about 6,700 miles of track currently in operation) will likely take place because another

185 miles of track are pending abandonment before the Interstate Commerce Commission (ICC). In addition, it is anticipated that abandonment applications will be filed before the ICC within three years for another 118 miles of railroad track and the potential for abandonment is being studied for another 235 miles of track.

Because a large percentage of these low traffic lines available for subsidy and those currently being subsidized are located in western Ohio, the main grain producing area of the state, many shippers are greatly concerned about the impact of this rail line abandonment upon grain marketing and transportation. In order to retain rail service, the grain elevators located on these lines may choose to subsidize the low traffic line on a matching basis with the Federal monies currently authorized to continue until June 30, 1981. On the other hand, if the low traffic line is abandoned, the grain elevators will have to seek alternative modes of transportation which may be more expensive but also more dependable.

Grain is transported from Ohio elevators by three principle methods: truck, rail hopper cars and water carrier (barge for those elevators located on the Ohio River or ships from the Toledo area). Semi-trailers are the usual form of truck transport although a few elevators use three to five hundred bushel farm trucks. Elevators may use rail in single car and multiple car of three, five, or ten and 60 or 100 car train units depending upon the availability and size of rail siding. About 64 percent of all grain from central and southwestern Ohio was shipped by rail in 1975. Rail service in this region is most important for wheat and least important for soybeans (Table 1). However, actual bushels of corn shipped by rail is larger than that for wheat because corn production in the region is five times that of wheat. Although data on barge shipments were not reported by the surveyed firms, barge shipments on the Ohio River reached about 60 million bushels in 1976 [11].

The Model

Although many different analytical methods have been used to study grain transportation in recent years, the most popular technique has been some type of a linear programming model which has been used by Ladd and Lifferth [10], Baumel et al. [2], Bunker and Hill [3], Tyrchniewicz and Tosterud [17] and other [8]. Even though Fuller et al. [7] have recently used network analysis, relatively few studies have applied this technique to agricultural economic problems. This paper incorporates the network technique to formulate the grain transportation problem as a constrained network flow which is solved by the Out-of-Kilter Algorithm (OKA) [4,5]. The objective is to estimate a set of flows through the arcs that minimizes total costs of grain transportation and handling which satisfies all demands without violating the capacity limitations of the network. The OKA solution yields the flow that

Table 1: Proportion of Grain Shipped By Truck and Rail from Central and Southwestern Ohio Elevators, 1975-76

Grain	Truck	Rail
	%	
Corn	31	69
Soybeans	64	36
Wheat	26	74
Total Grain	36	64

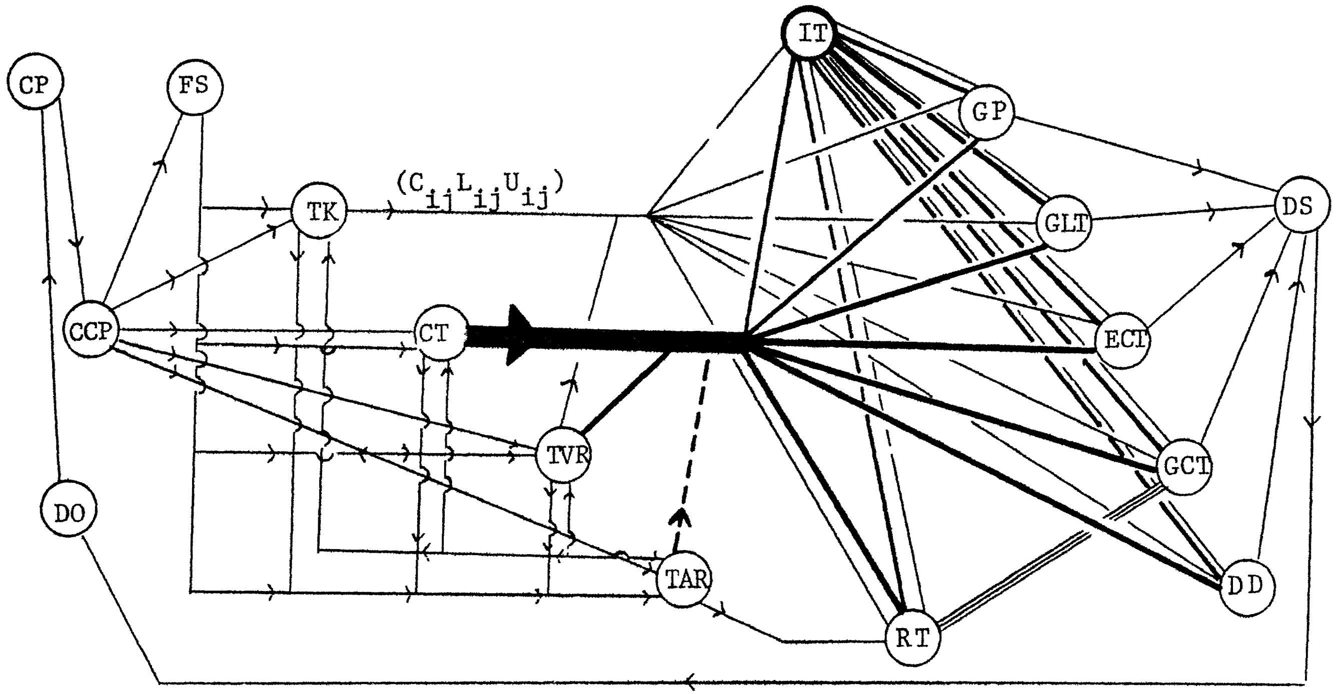
Source: Michael D. Kane [9]

minimizes total cost (min $\sum_i \sum_j C_{ij}X_{ij}$) subject to a circulation principle that what flows into a node must flow out ($\sum_j X_{ji} - \sum_j X_{ij} = 0$) and subject to the lower and upper capacities of the arcs ($X_{ij} \leq U_{ij}$ and $X_{ij} \geq L_{ij}$).[5/]

A network consists of nodes, diagrammed as circles, connected by arcs (Figure 1). The unidirectional flow on the arc (ij) is illustrated as movement from the initial lower case letter to the following lower case letter; for example, flow from node i to node j is designated by X_{ij}. Since each arc has a specific capacity and cost of flow, the upper capacity from node i to node j is designated as U_{ij}, the lower capacity is designated as L_{ij} and the cost incurred to move a unit of product from node i to node j is designated by C_{ij}. The U_{ij} specifies the maximum amount which may flow over any particular arc while the L_{ij} specifies the minimum amount which must flow over any particular arc. If an L_{ij} equals zero grain may flow over the arc but no grain is required to flow on that arc. To complete the network, a dummy origin and a dummy sink are required to assure that total supply equals total demand.

The Ohio Grain Rail Abandonment Model (OGRAM), a multiperiod, transhipment model which consists of 1,245 nodes connected by 10,464 arcs, minimizes the total cost of grain transportation and handling from farm origins to final destinations in a thirty one county area of central and south-

Figure 1. The Ohio Grain Rail Abandonment Model



<u>Key</u>

Transport Modes

- Rail
- Barge
- Truck
- Abandonment

Nodes

DO - Dummy Origin
CP - County Grain Production
FS - Farm Storage
TK - Truck Only Elevator
CT - Country Terminal
TVR - Truck Viable Rail
TAR - Truck Abandon Rail
CCP - County Corn Production

Nodes

IT - Inland Terminal
RT - River Terminal
GP - Grain Processor
GLT - Great Lakes Terminal
ECT - East Coast Terminal
GCT - Gulf Coast Terminal
DD - Domestic Destinations
DS - Dummy Sink

western Ohio. The network in Figure 1 represents grain movement from one county in one time period. The major activities are farm storage and drying, elevator storage and drying, elevator receiving and load-out and transportation by truck, rail and barge. Rail shipping activities are subdivided to represent the single car, multi-car and unit train options which elevators have available in Ohio. In addition to fixed supplies and demands for grain, the model has beginning and ending farm and elevator grain inventories and utilizes the current elevator structure for handling grain. To coincide with the grain harvesting and shipping patterns, the network is divided into three time periods each of which is similar to that presented in Figure 1. The first time period, June through August, covers the wheat harvest and marketing period and the second time period, September through December, covers the corn and soybean harvest and the marketing period prior to closing of the Great Lakes for shipping. The final time period, January through May, covers the balance of the marketing year.[6/] Arcs representing storage activities and storage costs connect each node from time period one to time period two to time period three so that grain can be transferred over time as well as space. The C_{ij} on the storage arcs equals the cost of storage from one time period to another at that particular node and the U_{ij} is set equal to the maximum storage capacity of that facility whereas the L_{ij} is set equal to zero since no minimum storage is required at that particular facility.

To simulate this grain transportation and handling system, the OGRAM network incorporates four stages as follows (1) grain origin stage, (2) county grain flow stage, (3) grain transport stage, and (4) grain destination stage. In the grain origin stage, grain flows from the dummy origin (DO) to the county grain production node (CP) with an upper limit (U_{ij}) on that arc equal to the sum of wheat and soybean production plus the marketable surplus of corn in that county for the crop year 1975 and a lower limit (L_{ij}) equal to zero. From the CP node the flow is to the county corn production node (CCP) in Figure 1 with a U_{ij} equal to the marketable surplus of corn in the county Although not shown in Figure 1, similar nodes for wheat and soybeans would have a U_{ij} equal to county wheat production (CWP) and county soybean production (CBP) respectively. There are no costs (C_{ij}'s) assigned for flow from the node DO to these nodes because no economic function is performed in this stage.

To analyze the impact of rail abandonment in the county grain flow stage, the methods of transport serve as the basis for classification of the elevators into grain shipping nodes. The nodes represent: (1) farm storage (FS), (2) elevators using truck transport only (TK), (3) elevators using truck transport and who ship by rail in unit trains (CT), (4) elevators that utilize truck and rail service but will not suffer rail abandonment (TVR) and (5) elevators with truck and rail service but are located on a branch line which may be abandoned (TAR). As shown in Figure 1, grain may flow to any of these five nodes from the farm origin node (CCP) and from farm storage to any of the elevator nodes, however, grain is not permitted to flow from the elevator nodes back to farm storage. The farm storage node is included to assess the possible changes in on-farm storage due to rail abandonment. In addition, the network permits intra-county transfer of grain among elevator nodes which would permit elevators that lose rail service to trans-ship grain to a nearby elevator. In the county grain flow stage, charges ($C_{ij's}$) are incurred for trucking activities, grain receiving at elevators and drying of corn. Since wheat and soybeans generally do not require any drying before storage or shipment, no drying charges apply for these two products. Because trucking capacity at the county stage was not reported as a problem by the grain elevators, no upper limit (U_{ij}) was used, however, an upper capacity limit was set for the corn drying activity on farms and elevators and the elevator receiving activity.

From the county elevator nodes, grain may be shipped by truck or rail either directly to final destinations or to intermediate nodes labelled inland or river terminals (IT, RT) which then ship to final destinations. Except for the truck only node (TK), all county elevator nodes and intermediate nodes are linked to final destinations by both truck and rail transport arcs so that all final demands may be met by any mode of transportation. On the trucking activities, no lower or upper limit is utilized while the C_{ij} is set according to the commercial rate structure and varies by mileage increments. On the other hand, rail shipping activities which have many rates (C_{ij}'s) depending upon size of shipment are different for each elevator type. For example, the CT and IT nodes have unit train rates as well as multi-car rates for shipments of three to ten cars but the TVR and TAR nodes only have single car or multi-car rates up to ten cars depending upon the type of elevator facility and past shipping patterns. Rail line abandonment is simulated by setting the upper limit on the rail load-out arcs equal to zero for those elevators which are located on rail lines subject to abandonment. This restricts the flow to zero and consequently no rail shipments occur from these elevators.

The final destinations for this grain are: grain processors (GP), Great Lake Terminals (GLT), East coast terminals (ECT), Gulf coast terminals (GCT) and domestic destinations (DD). Ending inventories also act as final destinations. Since all final destinations have separate demands in each time period, the upper limit is set equal to the lower limit in order to assure that demands are met at each destination.

The Data

To obtain the basic data on grain market structure and flows for crop year 1975/76, interviews with a stratified random sample of 58 grain elevators in 31 counties of western and southwestern Ohio were completed in the summer of 1976. According to the Ohio Branch Line Plan there were 17 rail lines with a total of 134 miles of track subject to abandonment or available for subsidy in this 31 county area [13]. These 17 rail lines varied from 2 to 35 miles in length with 18 elevators located on these lines. Information was collected on elevator size, utilization of transport modes, grain receipts, grain flows over space and time and rail line abandonment. Corn, soybean and wheat production for each county was obtained from the Ohio Agricultural Statistics for 1975 [12]. Since only corn was assumed fed to livestock in that area in 1975, the transportable surplus of grain was defined as soybean and wheat production plus corn production adjusted for feed use in each county. County feed use was estimated from county livestock numbers for six classes of livestock multiplied by corn consumption rates for each class.[8/]

County farm storage capacity and cost data were estimated for a 20,000 bushel batch in bin dryer system from a recent study by Smith and Baldwin [16]. Operating costs for handling and storing grain in commercial elevators were obtained from the Economic Research Service publication entitled, Feed Situation [18]. Railroad rates, available from Free et al. [6], for the single car, three, five and ten multi-car and 60 and 100 car unit train rates were used in the model. Not all rates were used for each elevator. To determine which rate options should be used for a particular elevator type, the elevator shipping patterns were analyzed.

Results

Base Solution

Analysis with the OGRAM network involves a comparison of two optimal solutions: the OGRAM base solution (pre-abandonment) and the OGRAM abandonment solution. In the OGRAM base solution, aggregate total transfer costs equal slightly more than $71 million to handle more than 297 million bushels of grain in this system (Table 2). Of this total flow, corn, soybeans and wheat represent 59 percent, 19 percent and 22 percent respectively. The most important market destinations for this grain flow are within Ohio (22%), the Northeast (5%), the Southeast (17%), East coast terminals (27%), Gulf coast terminals (9%), and others including ending inventory (20%).

Of the six elevator types identified in Table 2, the most important elevator type (truck viable rail) receives over 65 million bushels of grain. In second and third place are the country terminal and truck only elevator types which receive 51.4 and 47.8 million bushels respectively. The elevators which will suffer rail line abandonment handle 23.8 million bushels of grain or about 11 percent of all elevator receipts at a cost of $524,590. As can be seen from the rail load-out activity, these elevators ship 18.3 million bushels (nearly 80 percent of their shipments) by rail and the remainder (4.5 million bushels) is shipped by truck. Because the elevators which will suffer rail line abandonment do not have the capa-

Table 2. Summary of Yearly Grain Flow and Cost By Activity and Elevator Type, OGRAM Base Solution, Ohio, 1975-76

Network Activity	Amount 000's Bu Cost in $	Elevator Type: Truck Only Available	Truck Viable Rail	Truck Abandon Rail	Country Terminal	Inland Terminal	River Terminal	Totals All Elevators
Harvest to Elevator	Amount	35,960	52,958	17,240	31,166	19,071	-	156,395
	Cost							
Farm Storage to Elevator	Amount	11,121	12,535	6,605	16,639	9,949	-	56,849
	Cost							
Farm Drying	Amount							37,548
	Cost							$4,355,568
Elevator Grain Receipts	Amount	47,831	65,493	23,845	51,398	24,677	-	213,244
	Cost	1,052,282	1,440,846	524,590	1,027,960	493,540		$4,539,218
Elevator Drying	Amount							92,513
	Cost							$6,013,345
Elevator Storage	Amount	15,814	69,744	5,664	14,257	31,507	1,950	138,936
	Cost	1,210,505	5,296,120	490,910	780,640	1,272,350	130,650	$9,181,175
Farm Storage	Amount							76,105
	Cost							$9,995,340
Truck Load-Outs	Amount	52,030	18,813	4,495	-	-	-	75,338
	Cost	1,456,840	526,764	125,860	-	-	-	$2,109,464
Rail Load-Outs	Amount	-	42,299	18,352	50,302	33,791	-	144,744
	Cost	-	1,353,568	587,264	955,738	642,029	-	$3,538,599
Intrastate Truck	Amount	52,030	18,813	4,495	-	-	-	75,338
	Cost	4,092,436	1,437,601	404,098	-	-	-	$5,934,135
Multi-Car Rail	Amount	-	42,299	18,298	24,215	9,719	-	94,531
	Cost	-	8,227,404	3,543,128	4,494,339	2,134,580	-	$18,399,451
Unit Trains	Amount	-	-	-	26,079	24,072	-	50,151
	Cost	-	-	-	3,781,455	3,433,075	-	$7,214,530
Total Cost								$71,280,825

bility to ship by unit train, they use single and multi-car rail. Since these same elevators store only four percent of all grain stored in the elevator sector they are a relatively unimportant part of the elevator storage system.

In the OGRAM base solution rail shipments from all elevator types equal 144.7 million bushels which is nearly double the 75.3 million bushels shipped by truck. Whereas the interstate grain moves by rail, mainly multi-car and unit trains, the intrastate grain is shipped almost entirely by truck. Even though unit train shipments from inland and country terminals account for a substantial amount of grain (slightly over 50 million bushels), almost twice that amount (94 million bushels) is shipped by single and multi-car rail from the other elevator types. Thus, elevators which suffer rail line abandonment will lose single and multi-car rail service that will mean a loss of the interstate market for those elevators.

As indicated in the discussion of the model in the previous section, each elevator type has the alternative of shipping to every other elevator type within the county; however, no intracounty grain transfers occur in the base solution. The model and actual truck tariffs require a minimum charge of 5.5 cents per bushel transport charge within a 20 mile distance. Results indicate that such transfers would add significantly to total transfer costs and the lack of intracounty transfers in the OGRAM base solution is consistent with the observed behaviour of elevators.

Abandonment Solution

Since total transfer costs increase less than one percent ($253,197) with rail line abandonment, such an increase is not sufficient to cover the nearly $4 million in subsidies which the Ohio Branch line plan estimates would be needed to upgrade and continue service on the 17 branch lines. 8/ Even though the increase in total transfer costs is small, considerable changes occur in grain elevator flows, transportation and storage throughout the region. As Table 3 indicates the truck abandon rail elevator types lose 18.3 million bushels of grain rail shipments in the OGRAM rail abandonment solution. Although this loss of rail service causes these elevators to lose slightly over three-fourths of the grain which they handled they are not eliminated from the rail abandonment solution. When the truck abandon rail elevators lose rail service they also lose the interstate market for grain but they acquire new intrastate destinations which they service by truck at a higher cost. These elevators ship by truck about 4.3 million more bushels of grain to these new intrastate destinations at a cost of $395,397 in added transportation charges. However, the truck abandon rail elevators gain these new intrastate destinations at the expense of the smaller truck only elevators which, as can be seen in Table 3, lose about 4.5 million bushels of truck shipments.

Table 3. Grain Transfer Cost and Flow Changes by Elevator Types and by Network Activity, OGRAM Abandonment Solution, Ohio, 1975-76

Network Activity	Amount 000's Bu. Cost in $	Elevator Type					Total All Elevators
		Truck Only Available	Truck Viable Rail	Truck Abandon Rail	Country Terminal	Inland Terminal	
Harvest to Elevator	Amount	(2897)[a]	9348	(6644)	294	----	101
	Cost	----	----	----	----	----	----
Farm Storage To Elevator	Amount	588	5769	(6166)	----	----	191
	Cost	----	----	----	----	----	----
Elevator Grain Receipts	Amount	----	----	----	----	----	----
	Cost	----	----	----	----	----	($638)
Elevator Drying	Amount	(3379)	6564	(4973)	1788	----	----
	Cost	($219,635)	$426,660	($323,245)	$116,220	----	----
Elevator Storage	Amount	(138)	(687)	(225)	1813	(1813)	(1050)
	Cost	($6,210)	($30,915)	($10,125)	$59,829	($49,829)	($47,250)
Farm Storage	Amount	----	----	----	----	----	1050
	Cost	----	----	----	----	----	$94,500
Truck Load-Out	Amount	(4577)	270	4307	----	----	----
	Cost	($128,156)	$7,660	$120,540	----	----	----
Intrastate Truck	Amount	(4577)	270	4307	----	----	----
	Cost	($380,873)	$29,969	$395,397	----	----	$44,473
Rail Load-Out	Amount	----	14,796	(18,352)	4122	(566)	----
	Cost	----	$473,472	($587,264)	$78,318	($10,754)	($46,228)
Multi-Car Rail	Amount	----	14,796	(18,352)	2328	2100	872
	Cost	----	$3,014,475	($3,533,138)	$422,951	$426,132	$330,420
Unit Train	Amount	----	----	----	(281)	(591)	(872)
	Cost	----	----	----	($40,745)	($81,335)	($122,080)
Total Net Cost of Rail Abandonment		----	----	----	----	----	$253,197

a/The parenthesis indicates a decrease in the bushels of flow and/or the cost for that network activity.

On the other hand, Table 3 also indicates that country elevators with viable rail service considerably increase the volume of grain merchandized, especially those with multi-car rail capability. Due to rail line abandonment, these elevators increase rail shipments by about 14.8 million bushels and nearly 100 percent of this increase is from the elevators which lost rail service. The elevators with viable rail service have a locational advantage with respect to the production areas and the abandoned rail lines so that these elevators realize increased grain volume with rail abandonment. The country and terminal elevators also increase the multi-car rail shipments by about two million bushels each in the rail abandonment solution.

Unit train shipments remain practically unchanged in the rail abandonment solution because of required model restraints and because it did not contain an investment activity to permit the construction of new unit train facilities.[9/] This constrained unit train movements to the existing facilities which did not have the location advantage with respect to the production areas and the abandoned rail lines that was observed for the country elevators with viable rail service. Over time it may be that some of the country elevators with viable rail service would expand their facilities to ship unit trains and thus result in an expansion of unit train shipments.

As Table 3 indicates, total grain elevator storage decreases by about one million bushels due to rail line abandonment which results in an increase in farm storage by the same amount during the model year. This increase in farm storage occurs under conditions which include the operating costs and capital costs of farm storage. The truck only, truck viable rail and truck abandon rail elevator types all store less grain in the rail abandonment solution.

Just as in the base solution no intracounty transfers occur in the rail abandonment solution. This result indicates that economically it is not feasible to trans-ship grain from the elevators which lose rail service to the elevators with viable rail service in that area. Rather, the farm origins will bypass the elevator losing rail service and ship grain directly to those elevators retaining rail service.

Conclusions and Implications

Aggregate results indicate that rail line abandonment will have an insignificant effect upon the total transfer costs of grain which amounted to about $71 million in the entire region. After rail line abandonment these costs increased by only $253,197 or 0.35 percent. However, major changes occur in the grain flow patterns which influence the storage and transport activities for many elevators in the region. Elevators losing rail service show substantially reduced grain receipts associated with a shift to intrastate trucking. With rail line abandonment, profit margins will be reduced because of the increased per bushel cost of truck transport and the higher cost per bushel caused by a reduced grain volume. Model results indicate these facilities will remain viable because of the importance of intrastate truck transport to satisfy grain demands within the State of Ohio. But a reasonable return on investment is the primary incentive to remain in operation. If the profit margins are insufficient over the long run, many of the facilities which lose rail service will close their doors because the profit incentive will no longer be great enough to cover the risk involved in operations. In the future, elevators that lose rail services under the RRRA of 1973 must become more diversified and service oriented if they wish to attract more business. Since they must be prepared to offer the services which are neglected at facilities concentrating on rail volume shipments, they will probably specialize as feed mills, farmstead equipment suppliers, custom fertilizer applicators, etc.

When the elevators that lose rail service offer lower prices to farmers due to the increased cost of truck transport, these lower prices will stimulate an increase in farm storage because farmers will become more selective in timing their grain marketings. More grain will be held on farms and shipped longer distances to large elevators which can offer higher farm prices because of more favorable rail rates.

The loss in grain receipts for elevators which lose rail services appears as gains in grain receipts for country elevators with viable rail services. Model results indicate that abandonment heavily favors elevators that have viable multi-car rail services and are close to the site of production. These elevators may expect to receive nearly 80 percent of the grain diverted from elevators that lose rail services while the remaining twenty percent will move to country terminals.

Country elevators capable of single and small multiple car rail shipments will supply much of the domestic demands for Ohio grain in the eastern and southeastern United States. Because of the current rail rate structure, country elevators remain competitive with terminals in this market. Many terminals specialize in the larger multi-car shipments of grain to take advantage of export rates. The domestic users of grain generally do not have facilities to handle shipments of rail cars in units greater than three or five cars, so the terminal facilities will frequently neglect these demands.

Greater road use by heavier vehicles will occur as a consequence of the change of grain flow patterns. The major portion of this increase in truck traffic will occur on primary rural roads and bridges not built to withstand the heavier loads. Rural communities which have elevators that lose rail service may have to increase taxes to cover the costs of road and bridge repair hastened because of the increase in semitruck shipments from facilities losing rail service. Communities that have elevators with viable rail service will also have increased road use due to larger, more numerous truck grain shipments to elevators in their locales.

FOOTNOTES

1. The distribution of these increased costs between consumers and producers depends upon the price elasticities of demand and supply for the products. The more inelastic the demand curve relative to the supply curve the greater the proportion of the higher cost which consumers will pay in the form of higher food prices.
2. Consolidated Rail Corporation (Conrail), a profit oriented government owned and operated corporation which began operation April 1, 1976, is a major feature of the reorganization plan. Conrail assumed control over the bankrupt Penn Central and several other railroads in the region. These railroads are the Lehigh Valley, Lehigh and Hudson River, the Reading, The Central of New Jersey, The Erie Lackawanna, and the Boston and Maine.
3. A financially self-sufficient line is one that: (a) is capable of generating sufficient revenue to cover approximately 90 percent of the costs incurred on the light density line itself as well as the variable costs of moving that branch line generated traffic over other lines to its destination or interchange with another rail carrier; (b) while not currently self-sustaining, can be made viable by reasonable rate adjustment (10 percent or less); or (c) while not currently self-sustaining, will be made so because of identifiable traffic growth in the near future.

4. Ohio's position in the subsidy program is unique because a provision in the State's Constitution forbids the use of public funds to subsidize private corporations. The shippers will have the responsibility to form a legal entity, sign the agreement with the carriers and provide the matching funds.
5. Further information on the structure and solution procedure of the algorithm may be obtained from Ford and Fulkerson [5] and Durbin [4].
6. The network must be duplicated for each additional time period with new arcs connecting the nodes that include storage costs and capacity information.
7. See Kane [9] for additional information on sample design, data sources and estimation methods.
8. Since the price effect from changing markets due to rail line abandonment is not included in the cost minimizing model, it is likely that the actual costs to the elevator losing rail service is understated.
9. The network formulation cannot represent the concave cost functions characteristic of rail rates. Therefore, an upper limit is set according to the estimated number of unit trains shipped from the individual facility in a given time period. This restraint is necessary or all grain will flow through unit train facilities--a phenomenon yet to occur in the real world.

REFERENCES

[1] Baldwin, E. D. and J. W. Sharp. Grain Market Structure, Flows, and Functions of Elevators and Processing Firms. Research Bulletin 1087. Ohio Agricultural Research and Development Center. Wooster, Ohio. July, 1976.

[2] Baumel, C. Phillip, John J. Miller, and Thomas P. Drinka. "An Economic Analysis of Upgrading Seventy-one Branch Rail Lines in Iowa." American Journal of Agricultural Economics 59(1977):61-70.

[3] Bunker, A. R. and L. D. Hill. "Impact of Rail Line Abandonment on Agricultural Production and Associated Grain Marketing and Fertilizer Supply Firms." Illinois Agricultural Economics 15(1975):12-20.

[4] Durbin, E. P. The Out of Kilter Algorithm: A Primer. Rand Corporation. Santa Monica, California, December, 1967.

[5] Ford, L. R. and D. R. Fulkerson. Flows in Networks. Princeton: Princeton University Press, 1962.

[6] Free, W. J. et al. Transportation Rates for Corn, Wheat and Soybeans. Southern Cooperative Regional Series No. 227. National Fertilizer Development Center. Tennessee Valley Authority. Muscle Shoals, Alabama. February, 1978.

[7] Fuller, Stephen W., Paul Randolph, and Darwin Klingman. "Optimizing Subindustry Marketing Organizations: A Network Analysis Approach." American Journal of Agricultural Economics 58(1976):425-36.

[8] Gerald, John O. et al (Edts). Proceedings of the National Symposium on Transportation for Agriculture and Rural America. DOT-TST-77-33. U. S. Department of Transportation. Washington D. C., August, 1977.

[9] Kane, Michael. "The Impact of Rail Reorganization on Grain Activities, Flow Patterns and Costs in Central and Southwestern Ohio." Unpublished M.S. Thesis. Department of Agricultural Economics and Rural Sociology. The Ohio State University. Columbus, Ohio, 1978.

[10] Ladd, G. W. and D. R. Lifferth. "An Analysis of Alternative Grain Distribution Systems." American Journal of Agricultural Economics 57(1975:420-30.

[11] Larson, Donald W. and Michael D. Kane. Western Ohio Grain Flows and Transportation Modes, 1975-76. Research Circular No. 244. Department of Agricultural Economics and Rural Sociology. The Ohio State University and the Ohio Agricultural Research and Development Center. November, 1978

[12] Ohio Crop Reporting Service, Ohio Agricultural Statistics, 1975. Annual Report. Columbus, Ohio. May, 1976.

[13] Ohio Department of Transportation. Phase II Ohio Branch Line Plan, December 1975. Amended February, 1976. Columbus, Ohio.

[14] Public Utilities Commission of Ohio. Division of Tariffs and Schedules. Columbus, Ohio. September, 1976.

[15] Rail Services Planning Office, The Rail Revitalization Act of 1976. United States Railway Association Publication No. 254. Washington D. C., April, 1976.

[16] Smith, Roger W. and E. Dean Baldwin. Economics of Farm Drying and Storage Systems in Ohio. Economic and Sociology Series 519. Cooperative Extension Service: The Ohio State University. Columbus, Ohio. May, 1975.

[17] Tyrchniewicz, E. W. and R. J. Tosterud. "A Model for Rationalizing the Canadian Grain Transportation and Handling System on a Regional Basis." American Journal of Agricultural Economics 55(1973):805-813.

[18] United States Department of Agriculture, Feed Situation. Economic Research Service Publication No. 252. Washington D. C., February, 1974.

[19] United States Railway Association, Final System Plan, Volumes I and II. Washington D. C., July, 1975.